St. Petersburg University

Graduate School of Management

Master in Corporate Finance

CEO CHARACTERISTICS AND INNOVATIONS: AN EMPIRICAL STUDY OF EUROPEAN PUBLIC COMPANIES OF PHARMACEUTICAL INDUSTRY

Master's Thesis by the 2nd year student

Concentration — Corporate Finance

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ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

Я, Тихенькая Ольга Вячеславовна, студентка второго курса магистратуры направления «Менеджмент», заявляю, что в моей магистерской диссертации на тему «Взаимосвязь характеристик CEO и инновационности компании: исследование публичных компаний фармацевтического рынка ЕС», представленной в службу обеспечения программ магистратуры для последующей передачи в государственную аттестационную комиссию для публичной защиты, не содержится элементов плагиата.

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24.05.2018 (Дата)

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I, Olga Tikhenkaia, second year master student, program «Management», state that my master thesis on the topic «CEO characteristics and innovations: an empirical study of European public companies of pharmaceutical industry» which is presented to the Master Office to be submitted to the Official Defense Committee for the public defense, does not contain any elements of plagiarism.

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24.05.2018. (Date)

АННОТАЦИЯ

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Факультет	Высшая Школа Менеджмента
Направление подготовки	38.04.02 “Менеджмент” (Профиль: Корпоративные финансы)
Год	2018
Научный руководитель	Ильина Юлия Борисовна
Описание цели, задач и основных результатов	То, насколько компания инновационна во многом определяет ее успех на рынке и потенциал для дальнейшего роста и развития. Особенно важны инновации в фармацевтической индустрии, помогая создавать конкурентное преимущество на рынке. В развитии инновационного потенциала особую роль играет генеральный директор, поскольку именно он определяет стратегию роста компании. Цель данной работы – определить, существует ли взаимосвязь между различными характеристиками генерального директора и степенью инновационности компании, которая измеряется объемом вложений в R&D и числом новых патентов, полученных в течение года. Для достижения поставленной цели были изучены особенности инновационного развития в фармацевтической индустрии, определены метрики измерения инновационности компании. Кроме того, для формулировки гипотез данного исследования, был проведен анализ научной литературы о роли генерального директора в компании и личных характеристиках, которые могут влиять на степень инновационности компании. В работе было простроено три эмпирические модели, которые были направлены на получение результатов о том, существуют ли взаимосвязи между определенными характеристиками генерального директора и степени инновационности компании. Результаты были использованы для формулировки управленческих рекомендаций. Результаты исследования показывают, что возраст, уровень и область высшего образования, сеть знакомств, заработная плата и факт, что директор был выбран среди сотрудников компании, имеют взаимосвязь с уровнем инновационности компании, которая измеряется расходами на R&D и числом новых патентов за год. Работа имеет теоретическую и практическую значимость.
Ключевые слова	Генеральный директор, инновации, фармацевтика

ABSTRACT

Master Student's Name	Olga Tikhenkaia
Master Thesis Title	CEO characteristics and innovations: an empirical study of European public companies of pharmaceutical industry
Faculty	Graduate School of Management
Main field of study	38.04.02 “Management” (specialization: Master of Corporate Finance)
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Academic Advisor's Name	Yulia B. Ilina
Description of the goal, tasks, and main results	In pharmaceutical industry, the level of innovativeness may play a crucial role strategically and CEOs are essential for driving innovation being the central element and the main driving force of any innovation process. The goal of the following paper is to identify the relationship between CEO characteristics and innovativeness of the public pharmaceutical companies in European Union measured by R&D expenditures and number of new patents obtained. To achieve this goal the topic of innovations was studied to determine the ways innovations in pharmaceutical industry can be measured. Moreover, literature review on the topic of corporate governance and relationship between CEO characteristics and company innovativeness was studied to formulate hypotheses of the study. Three empirical models were tested to obtain results on the existence of the relationship between personal characteristics of CEO and company innovativeness. Based on obtained result the managerial implications were developed. Study suggests that age, level and field of education, experience in pharmaceutical industry, personal network, remuneration and fact that CEO was promoted to CEO position from inside are related with level of innovativeness that is measured by number of new patents obtained and R&D expenditures. This research paper has a theoretical contribution to the existing pool of literature by providing more insights about role of CEO characteristics in company innovativeness and also may help pharmaceutical companies in assigning new CEO.
Keywords	CEO, innovations, pharmacy

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Introduction

Innovations play a vital role for the firm regardless of the industry where company operates, and, the level of innovativeness considered as the one of the most important predictors of its performance, especially in the long term perspective [Torchia, Calabro, Huse, 2011]. Innovation is a key element in helping firms to find and develop a competitive advantage [Hitt, Hoskisson, Johnson, Moesel, 1996], expand market share, and increase their performance [Franko, 1989]. Many rankings [the Thomson Reuters Top 100 Global Innovators] regularly make the ranking of the most innovative firms in the world based on the analysis of patent-related metrics that shows the importance of this factor.

The level of innovative activity within a company may be determined from a certain set of quantitative and qualitative criteria. The quantitative criteria includes share of R&D expenditures in the total expenditures of the organization, the share of innovative products in the volume of products produced by the organization, number of patents company receives each year. The qualitative criteria characterizing the level of innovative activity may include prevalence in the organization of technological innovations (product or process) regarding organizational and marketing innovations. The choice, which measure to choose, depends on industry.

In pharmaceutical industry, the level of innovativeness may play a crucial role strategically. Innovative medicinal products or technologies are new drugs, dosage forms or means of delivery of active substances. These innovations may improve or even radically change the prognosis of many diseases, modify their course, reduce lethality, and significantly reduce the costs of the state for treatment and rehabilitation of patients, and extend the working age. This development creates enormous value for customer and skyrocket revenue of producing company. Especially in European market (EU), were many big players occupy the industry, the development of innovative products and new production processes may elevate the revenue and profit of one player and critically decrease these indicators for another. If we look at the pharmaceutical market - the main factor that projected to drive the growth is R&D expenditure that finally will turn into new products, services and methods of production.

It may be concluded that two main factors that can be interpreted as a measure of innovativeness in pharmaceutical industry are R&D expenditure and number of patents companies receive each year. **These two metrics represent how the level of innovativeness is measured in this paper.**

At the same time, the way company operates and which strategy follows highly depends on top management decisions, especially on Chief Executive Officer's (CEO's) decisions. CEOs are essential for driving innovation being the central element and the main driving force of any innovation process by affecting all stages of innovative management, development of innovative ideas and controlling the process of implementation of innovations. The **relationship of CEO characteristics on R&D activity and number of patents** in pharmaceutical industry is examined in this paper. CEO's characteristics such as age, degree and field of education, tenure, level of compensation and network may affect the R&D and patenting activity and all these factors will be analyzed. Previously, no researches of relationship between CEOs characteristics and company innovativeness in pharmaceutical industry in European Union were conducted.

The main **research goal** of this paper is to identify the relationship between CEO characteristics and innovativeness of the public pharmaceutical companies in European Union measured by R&D expenditures and number of new patents obtained.

The **research question** to be answered is: which CEO characteristics matter in increasing of innovativeness of a pharmaceutical firm and in what extent each of them matters. In particular, it is supposed to be determined that some of characteristics such as CEO age, educational level and field, tenure, remuneration, hiring from inside or outside and network does matter.

The **research objectives** are as follows:

- To conduct a literature review of research papers on the topic of innovations and, in particular, analysis of CEO characteristics and their relationship with innovations.
- To study the specifics of innovations measurement in pharmaceutical industry.
- To conduct an empirical study of determined CEO characteristics that may potentially have relationship with innovativeness of pharmaceutical company.
- To discuss the results of empirical study and develop theoretical and practical implications for results.

The methodology of the study is econometric modeling and regression models construction. The dependent variables are characteristics of company innovativeness, such as R&D expenditures and number of new patents received. Independent variables are characteristics of CEO of public pharmaceutical companies in EU. Three models are constructed to determine the relationships of CEO characteristics on company innovativeness: model for

R&D expenditures without time lag, model for number of new patents received with time lag 2 and model for new patents received with time lag 3.

In this thesis, **theoretical and practical contributions** are made. The new evidence about the correlation between the characteristics of CEO and the level of company's innovativeness in pharmaceutical industry in EU considered to bring theoretical value. Results obtained are formed in a form of practical guidelines that are expected to help companies to choose the best CEO based on factors that can predict the level of CEO's innovation orientation.

The research paper comprises an introduction, two chapters that include the analysis of theoretical background regarding research topic, statement and description of research methodology, empirical results, findings and discussion, theoretical and managerial implications of results obtained, conclusions, and limitations of the conducted research.

The first chapter starts from giving the definition of innovations and stating that there are various approaches to understand the innovations meaning. After that, the role of innovations in pharmaceutical industry is disclosed and discussed in order to understand the role of innovations in development of companies in this industry. This part is follows by discussing the ways of how innovations can be measured in order to choose the way of their measurement for this research. Further, the role of CEO in company management is discussed as well as the CEO role on innovations is described. The final part of the first chapter dedicated to the possible relationship of CEO's characteristics on firm innovativeness in pharmaceutical industry based on existing research papers. On this basis seven hypotheses have been formulated.

The second part is dedicated to the conducted empirical study. In the beginning of this chapter the description of methodology is given: three models are stated and the method of panel data analysis is chosen. After this the descriptive analysis of dependent, independent and control variables is given. This part is followed by analysis of empirical results that were obtained after conduction of regression analysis. Based on these results stated hypotheses were analyzed. Finally, the chapter ends with the discussion of the findings and analysis of possible managerial implications and limitations of research.

Chapter 1. Innovations and the role of CEO

1.1 The role of innovations and innovativeness measurement

Definition of innovations

Nowadays, the term “innovation” included everywhere: in company vision, mission, development plan and its objectives. In addition, it is not a rare case to see the position of Chief Innovation Officer (CIO) in the board members list in public companies. This pervasiveness of “innovation” term has resulted in being named one of the most overused word worldwide [O’Bryan, 2013]. But also such frequent use of this term resulted in fact that there is a prevalent misunderstanding what does “innovation” means. It leads to incorrect decision making and objective setting within firms and individuals and may explain fact that a lot of individuals find the innovation elusive [Kuratko, Covin, Hornsby, 2014].

The main misbelief is that innovation means something radically new in nature and minor changes in existing product does not count. In fact, a radical innovation is very challenging and complicated, usually require special resources, and bounded with a substantial risk that is much higher than in case of incremental innovation. Incremental innovation means smaller changes and balances the innovation process but still it is an innovation. Successful firms understand that different kind of innovation, starting from minor incremental innovations to major radical ones, play a huge role and tries to develop both.

The term innovation may be defined in the several ways. Various authors define it as a process: Baregheh, Rowleysays that it is a “multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace”, Bessant, Lamming, Noke argue that “innovation represents the core renewal process in any organization. Unless it changes what it offers the world and the ways in which it creates and delivers those offerings it risks its survival and growth prospects”, Bledow says that it is «the development and intentional introduction of new and useful ideas by individuals, teams, and organizations” [Baregheh, Rowley, &Sambrook, 2009; Bessant, Lamming, Noke, & Phillips, 2005; Bledow, et al., 2009]. Another look at innovation as on the outcome: Hobday argue that innovation is “a product, process or service new to the firm, not only new to the world or marketplace.”, Kumar highlights that it is “a viable offering that is new to a specific context and time, creating user and provider value” [Hobday, 2005 Kumar, 2013]. Thus, it can be concluded that two common definitions are “the introduction of something new” and “a new idea, method, or device”. Although they seem similar, there are some important distinctions but at the same time, both approaches are correct.

Thus, it is important to understand innovation as both an outcome and process and this understanding is crucial for organizations. By focusing on the outcome companies may face inefficiencies in innovation development process such as resource overconsumption. By focusing on process company may face bureaucracies that make it too difficult to achieve the results needed. Thus, view on innovations should be balanced: both processes and outcome determination are important. Both innovations as an outcome and innovations as a process include various types of innovation depending on area where the innovation was made.

Innovation as an outcome typically linked with new products and services introduction. However, these two examples are only a part of possible innovations as an outcome. In fact, innovations as an outcome include product, process, marketing, business model, supply chain and other innovations. Description of all innovations as an outcome is as follows:

- Product innovation means offering of a new products, programs or services. Product innovation can include cost reductions, improvement in existing products, extension of a product line and other. All these innovations are based on objective to increase profits by increasing in market share, product usage of both and strategies that companies use may be divided into four types: market penetration, product development, market development and diversification. In fact, the majority of organizations do not to focus on the only one type of product innovation. On the contrary, various types of new product projects have to be considered in one time to be able to assemble a new product portfolio that maximizes return [Cooper, Edgett, Kleinschmidt, 2002]. Product innovations are mostly about effectiveness.
- Process innovation aims to change the methodology or process to increase efficiency of processes within an organization by lowering costs, fastening production, increasing throughput. Process innovation is about efficiency. At the same time, by focusing strictly on process innovations ability for product innovations may be limited, because product innovations usually requires increase in costs, while process innovations aims to decrease them.
- Marketing innovation includes development of new methods of connection company with a customers and consumers. Usually marketing innovation is presented in a form of new promotional efforts to increase awareness and brand recognition.
- Business model innovation changes the industry. IBM in 2009 highlighted three types of business model innovation: industry model innovation that includes the evolution of value chain by expanding into new industries, revenue model innovation that increase revenue by offering of a new product or service mix and enterprise model

innovation that innovates the role played by enterprise and networks with vendors, customers, employees and other parties.

- Supply chain innovation is a change in supply technologies, business processes and network. These changes may be incremental and radical as well and can lead to the new value creation for stakeholders.

Innovations as a process refer to the way in which innovation should be arranged so that the outcomes will finally lead to fruition. In 2015 Product Development & Management Association published the process model for innovation by highlighting three phases: discovering, developing and delivering. Description of all these phases are as follows:

- The delivering phase is an essential clarification of innovation. The idea behind is that innovative product creation is not the end, execution that means getting this newly created offering into the hands of consumers and achieving market acceptance is highly important.
- The process of new product development refers to crucial steps in development, milestones setting. Development process include idea generation, its evaluation, business case development, preparation phase, technical development and testing.
- Discovering refers to the market analysis, current products comparison, landscape scanning and identification of the potential opportunities.

It is highly important to all organizations to understand innovations both as a process and as an outcome, because it is a requisite for longevity. Innovation leads to expanding of productive activities that, in turn, leads to economic growth. Innovations are everywhere. Data show that the share of innovative activities worldwide is exponentially growing and reach 2.4% of GDP worldwide [OECD, 2015].

1.1.1 Innovations in pharmaceutical industry

Pharmaceutical industry is driven by innovations. Deep understanding of the market needs is necessary, but still insufficient for determination of a firm success. Even if finding of effective drugs is vitally important for the millions of patients, 10-20 years of painstaking research can still give not a satisfactory result [Gilbert, Henske 2003].

The process of new product development takes a long time. This is the reason why in the majority of cases each company spends enormous amounts of money to R&D; no other industry is under such huge pressure to innovate. In terms of business, the positive momentum created by triumphant innovation can have a colossal, lasting for decades effect on the whole

pharmaceutical industry. Pharmaceutical companies are in the list of the top investors in R&D worldwide [European Commission Joint Research Centre, 2015].

Some analysts claims that pharmaceutical R&D accounts for 15 % share of all R&D expenditures worldwide - enormous amount for a single industry (figure 1) [Statista database, 2018].This R&D-based industry spends annually more than $100 billion on R&D, where main players, such as Novartis and Roche, spends $10–12 billion annually [IFPMA, 2016]. High attrition rates along with the long development times lead to the high R&D costs per new product, ranging from $1.24 billion to $1.32 billion and could even be higher if adjusted for other cost or inflation [Kaitin, K.I., 2010].

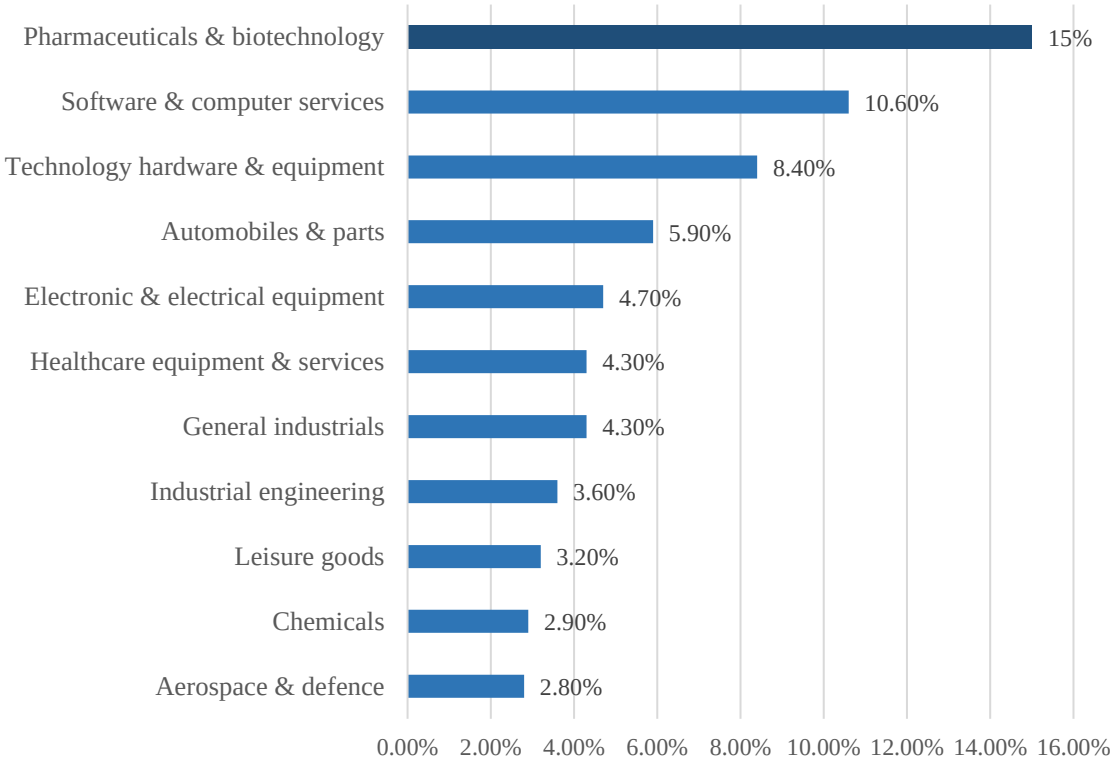

Figure 1 R&D intensity, by sector, 2016.

Source: Statista

Such high R&D costs could be justified. Every company is trying to find a “window of opportunity” for gaining a competitive advantage. The invention of new medicines, drugs and the improvement of existing ones serve as the engine of this industry. That is why the technology selection is crucial to underpin strategic research areas where the greatest financial and social benefits are projected to be [Dunmade, 2002].

Sometimes the accidental triumph of creating a completely new medicine in an area with no effective treatment is considered to be the pharmaceutical industry’s most defining

hallmark. Although these scientific discoveries are may create an outstanding competitive advantage over others, pharmaceutical companies often are consolidated via M&A, develop partnerships with various entities, outsourced information technology, back-office and R&D departments.

Modern medications can affect the quality and the duration of our life in ways, we couldn't imagine even a few decades ago. Some scientists even predict that the average length of life will be expanded by 10-20 years in the near future – this could be possible because of incredibly fast development of medicine. Over the last 20 years drugs have successfully improved the wellbeing of arthritis and Alzheimer's sufferers all around the Globe, decreased number of deaths from heart disease, may treat several types of cancer, and even HIV/AIDS [Khulji, Mroczkowski, 2006].

The number of deaths from cardiovascular disease has dropped by more than 28 % between 1997 and 2007. Innovations development also increased the effectiveness of medicines for stroke prevention, arrhythmia, sclerosis, and a lot of other diseases. Promising new drug introductions is a main source of competitive advantage for the companies in pharmaceutical industry. Moreover, the market is growing and it already reached $1.1 trillion in 2016. The USA is the largest pharmaceutical market, while European market is the second [Statista, 2018].

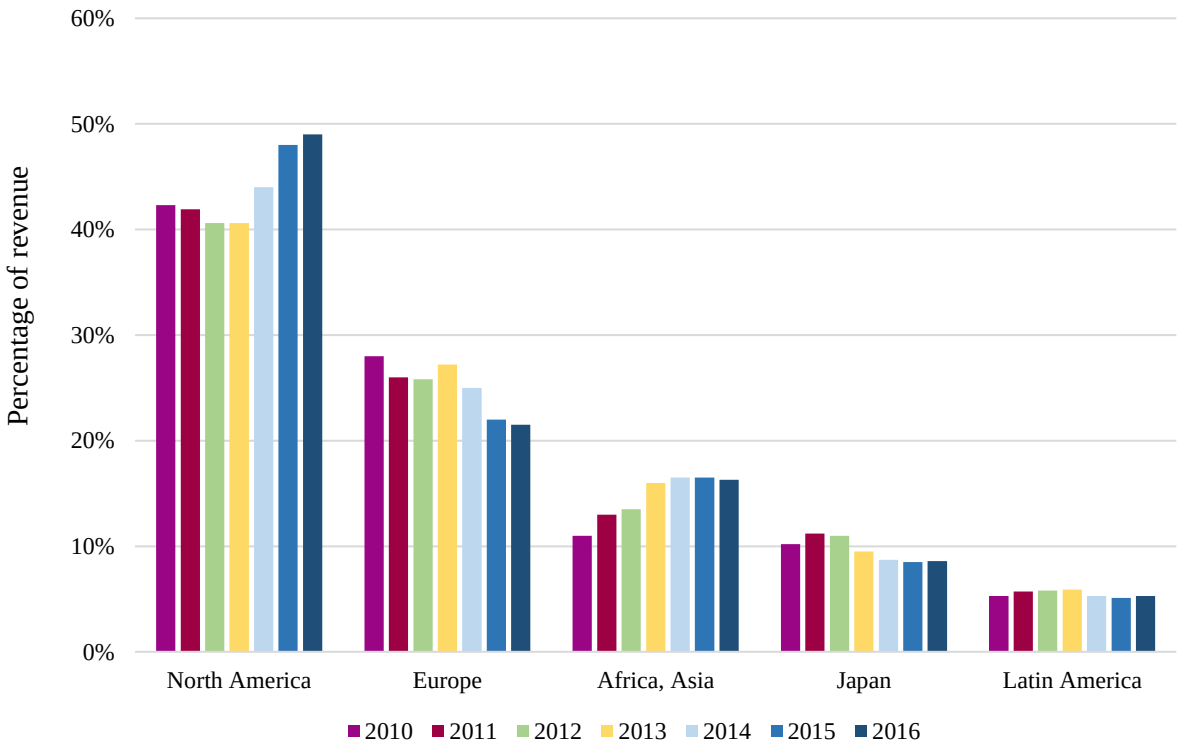

Figure 2 Distribution of global market revenue from 2010 to 2016, by region.

Source: Statista

As we can see from the data above the share of European market worldwide has a downward trend that means that to increase the share there should be made a lot of effort to accelerate the research activity in this market. If we look at the pharmaceutical market - the main factor that projected to drive the growth is R&D expenditure that finally will turn into new products, services and methods of production: by 2022, products that are currently in R&D stage will account for 13% of sales in Europe [Statista, 2018].

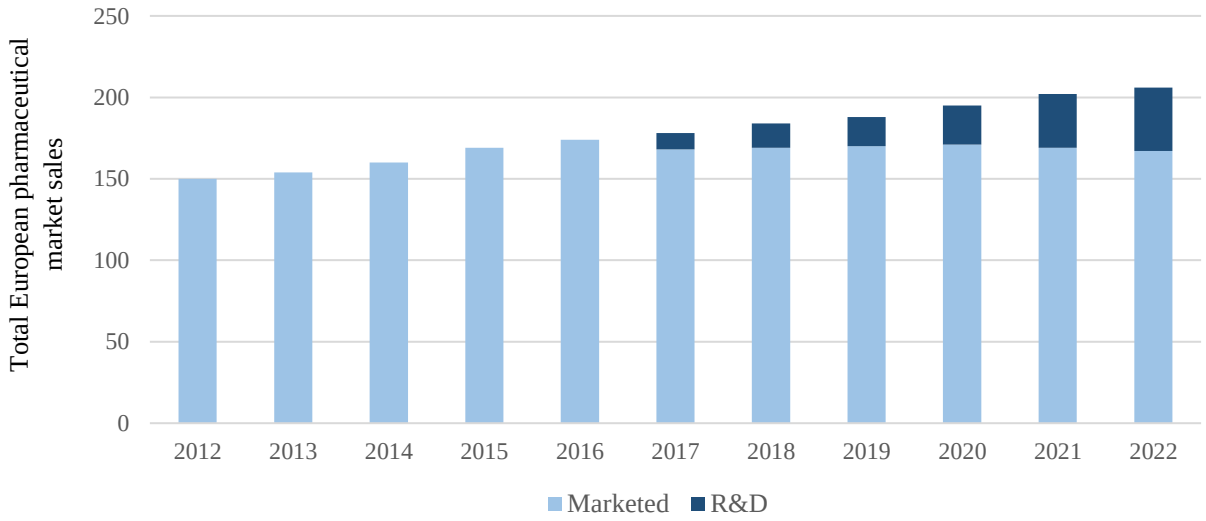

Figure 3 European pharmaceutical market, EUR billions.

Source: Statista

The effect of a new medicine launch often goes beyond the huge profits achieved that could take place especially due to patent protection and first-mover advantage. Incremental, subsequent improvements and modernizations involving greater efficacy, reducing of side effects, better dosage regimen, changes in the application way, improved formulations may greatly expand the market potential for the company-producer by adaptation of this drug for other categories of patients, for example, those who may benefit from other dosage protocols [Gupta, Kesarla 2013]. It may sound astoundingly: more than 50% of the new medicines introduced in last 5 years were not a new chemicals or biopharmaceuticals [IFPMA 2017].

In fact, the half of newly introduced products were an improved versions and changed formulations of existing ones. This is because such incremental drug modifications may improve a treatment, stimulate better patient compliance or enable a more convenient medicine delivery. It is important to note that recently released improved versions of an existing drug can ensure a cash flow continuity, create new streams of revenue for a company that will in turn increase value and returns of shareholders. In the other side of it, apart from creation a slightly better version of medicine for a billion of patients, there is also the great social and economic benefit.

To carry out R&D, manufacturing and marketing of new drugs, thousands of new jobs should be created [Selim, 2015]. This fact emphasizes the role of innovation in pharmaceutical industry as a powerful mechanism for economic progress.

At the same time, the development of a new medicine is not an orderly and predictable process. Despite the latest achievements in science and technology, the chance still plays a role in the discovery of effective compounds. Moreover, there is no way to ensure that years of intense, enormous R&D efforts and investment will pay off in the end.

The success rates in drug discovery remain extremely low. Furthermore, the market approval for a new drug depends on governmental agencies that are responsible for regulation and control of pharmaceutical industry in each country of region. Players on the market are motivated for profit increase and market share, while governments aim for national-wide development, social welfare, and technological advances [Bruun, Bennett, 2002]. These specifics together make the development and a life cycle of medicines completely different from any other technology-intensive industry.

Medicine innovation emerges at the age of state-of-the-art discoveries covered completely different sciences, such as engineering, IT, and biology. Using latest discoveries in these and other disciplines, this knowledge should be intersected in a way to create medicine for human health and life expectancy improvement. Inventing new medicines is eventually comprise an effective business process with a strict fiscal discipline and well-planned and justified strategic, organizational, and managerial decisions.

The European market nowadays faces a cost-containment policies implementation even while they attempt to develop the innovative products. The increasing from year to year number of Health Technology Assessment agencies and the various changes in pricing and reimbursement (P&R) procedures show that innovative drugs have been targeted by cost-containment policies as well. This is done in order to compete on the market effectively. In some cases, company develops product in alliance with other pharmaceutical companies and even on the country-level there are alliances. Also, countries combine their strength and knowledge to negotiate jointly on prices for newly developed and developing products. Ireland is going to unite with Austria, Belgium and Netherlands to boost their collective bargaining. Similar tendencies could be seen the Nordic countries, the Balkans, and in central and eastern Europe. All these actions aim to accelerate and facilitate innovations development in Europe.

Nowadays EU pursues two main objectives in its policy on drugs and other pharmaceutical products that should secure a high level of public health and innovation and

support high level of competition on the market to ensure that Europe continues to receive benefit from newly developed medicines. The first objective of policy requires that drugs and treatments should be affordable for people and that the quality of medicines should be high. Also the patients in EU should receive all necessary information timely, to be informed about various ways of treatment. The second objective of policy requires increase the competitiveness of European's pharmaceutical products. All these objectives are tied with innovations development.

Different sides of pharmaceutical innovation have been the object of analysis in various fields such as economics and marketing. However a majority of obtained findings have remained somewhat scattered, limited to the particular discipline in spite of broad applicability and importance. There are many sides of innovation creation that require further analysis. This is why each additional research may have a great relationship on this area, including, for example comprehensive overview of the business processes in innovation management or strategic planning. Furthermore, one of the biggest questions is how to measure the innovativeness of the company.

1.1.2 Approaches to measure the firm innovativeness

A lot of researchers and practitioners within various industries have studied the ways to measure innovation activity. This aim to measure company innovativeness from different sides may be explained by a few reasons. First, discovering how to measure innovations can assist firms in industries to understand their current innovations capabilities and opportunities and may help to find area of focusing to maximize innovation success. In addition, this understanding will help to identify strengths and weaknesses and break the barriers that stifle creativity and innovations. Benchmark indexes may also be developed based on the most innovative companies that may enforce innovation processes in less successful organizations.

In order to find how to measure innovations, it is important to choose and understand the definition of it. Innovation is "the introduction of a new product, service of process through a certain business model into the marketplace either by utilization of by commercialization" [Gamal, 2011]. Hence, the word innovation could mean completely different things: a new product, service, process and business model, but at the same time all these meanings contribute to the strengthening of competitive advance of certain firm. Such a broad definition proves the fact that innovation is a complex activity that cannot be measure with one simple indicator and the way of measurement may depend on industry and understanding of innovations meaning.

There are two different streams of innovation measurement. One stream measures innovation input, such as R&D expenditure, another measures innovation output, such as number of patents and citations.

R&D expenditures

While competition in all industries is growing from day to day, many companies should look for new ways of growing, and for some industries, in particular for the pharmaceutical industry, investments in R&D sound be significant [Balkin, Markman, & Gomez-Mejia, 2000]. That may enable firms to develop new products, processes and create a future competitive advantage [Barker & Mueller, 2002].

At the same time, R&D is closely related to the great uncertainty and complex tasks and for these reasons requires substantial resources, including information and market knowledge, technology, experienced human resources, and colossal financial capital [Chen & Hsu, 2009]. Moreover, the data on R&D availability, specifically in pharmaceutical industry, means that there is significant evidence on the relationship of R&D expenditures with companies' innovation input and, consequently, output.

R&D investment is the primary source of innovation development because it enable companies to create demanded capabilities [Balkin, 2000; Dalziel,2011]. Pharmaceutical companies are expected to grow in the next years mainly due to introduction of new medicines and thus, firms need to have sustained R&D spending and invest financial resources wisely. On contrary, a lack of R&D expenditure may prevent a company from being competitive [Kim et al., 2009] and may lead to time compression diseconomies that inhibit ability of a company to gain a dominating position over competitors due to early investments in innovation creation [Kor, 2006]. Because of the nature of pharmaceutical firms and benefits of R&D investment in promising area, fast responses are important for other players to increase their innovative capabilities.

R&D projects are complex and place considerable demand on various resources. Some authors suggests that maintaining a continuous volume of R&D expenditure is a driver for a company [O'Brien, 2003]. Significant resources are needed to ensure the uninterrupted R&D activity that, in turn, enhances innovative capabilities [Wincent, Anokhin2010].

However, some authors argue that R&D expenditure is not correspond to innovations. The reasoning behind is that not all innovative activities are really created in laboratories with a help of highly qualified researchers. Measures of R&D are relevant factor to measure

professional R&D activity, but sometimes there is an “informal” R&D that is proved to be negatively correlated with the technological complexity in company. In this case R&D may underestimate the innovation input for many companies [Fieler, 2011]. But this is true for SMEs and some not knowledge intensive industries, but not for pharmaceutical that is the reason why in this industry R&D may be a relevant indicator.

Due to importance of R&D expenditures in innovation activity, a majority of researches measure innovativeness with a use of indicators that are based on R&D expenditure. For example, JoonMo Ahn, Tim Minshall and LetiziaMortara in their research analyzed correlation between CEO characteristics and open innovation adoption and have measures innovations as R&D intensity of firm [Mo Ahn, Minshall 2017]. The same pattern could be seen in various other papers, because R&D data is available for many public companies [Gonzalez-Uribe 2017; Chen 2014]. At the same time, researchers use various indicators for measuring the R&D intensity. Some used the ratio of R&D expenditure to net sales [Hsien-Chang Kuo, Lie-Huey Wang 2017; Sam Yul Cho, Sang Kyun Kim, 2017] and others used the ratio of R&D expenditure to total assets [Hsien-Chang Kuo, Lie-Huey Wang 2017].

Patents

Using patent system, that includes legal registration in governmental agencies, company is able to protect its inventions. Patent obtaining gives many advantages for patentee, where the main one is protection from coping, manufacturing or selling and innovative product or service without patentee approval. If patents are properly processed, classified and organized, it is a great source of valuable information on innovations in industry. Over the last century, innovation metrics have included a number of patents as an output measure. Nevertheless, like any other factor, patents have strengths and weaknesses as a measure of innovations and these sides were analyzed by various researchers.

Undoubtedly, patent is a direct outcome of years of hard working and research and usually company obtain a patent if it is seen that invention should bring a great commercial impact [Mansfield, 1986; Sichelman, T., 2011]. Especially, it is an indicator for capturing the competitive dimension of innovation change. The process of patent obtaining is time consuming and costly that means that company will apply for it if the benefits are expected to overweight all costs and in case of pharmaceutical companies, this is often the case. The main advantage of patent obtaining is that by doing this you prevent any coping, manufacturing or selling your invented product or processes [Narin, F., 1987]. In pharmaceutical industry especially due to the

fact that R&D takes a lot of time and resources all inventions are usually patented. Moreover, some companies sell the license like any other asset, in order to get an additional stream of revenue for the business.

However, the truth is that many valuable innovations may still not be protected by a patent or even be patentable [OECD, 2009]. It is a fact that patents may vary in terms of their value and importance and there is a belief that there are patents that are not able to capture innovative output [Hu and Mathews, 2005]. Some researchers propose to use a patent citation rates as a measure of innovativeness. The idea behind is that citations may highlight the importance of an invention [Jaffe, 2001; Alcacer, 2006].At the same time, this creates a truncation issue that arises from the difference between old and new patents citations [Hu and Mathews, 2005].

Another alternative is a renewal fees that mean the total costs and time period for which the company pays renewal fees in order to maintain the legal value of the patent. Also, not all results of scientific research have to be protected by a patent in order to reach the industry. Nevertheless, various empirical studies suggest that a huge share of companies' innovations are patented. To be exact, companies usually apply for a patent in 65-85% of cases where a patent may be obtained. We can conclude that firms make use of patenting for the majority of their patentable inventions that is in particular true for pharmaceutical companies.

It is fact that patents have a greatest value in chemical and pharmaceutical companies where the cost of imitation is greatly less than the initial investments in R&D [Arundel and Kabla, 1998]. This means that number of patents is significant for company development and patenting activity fairly can be named one of the most important measures of the success of invention.

1.2 CEO characteristics and innovations

The role of CEO in company management

Over the past few decades, the issues of companies’ management have been actively analyzed. It this researches an important place is devoted to studying the relationship of the company's top management and its financial performance and other important indicators. One group of scientists argues that the actions of the manager are considerably limited by the institutional features of the company's functioning, for example, its inertness, dependence on the chosen development strategy and the availability of a certain set of resources. Due to this fact it is argued that top managers are not able to have a significant influence on the firm's activities

[Hannan, Freeman, 1977; DiMaggio, Powell, 1983; Haveman, 1993]. In other works, it is stated that the head of the company is seen as a strategic resource and along with other resources has a significant impact on the company's performance.

One of the fundamental researches in the field of studying the influence of top managers on firms' activities says that demographic and professional characteristics of managers can be considered as proxy variables for their managerial capabilities, the impact of which is reflected in the financial performance of companies [Hambrick, Mason, 1984]. This approach was called "The Upper Echelon Theory". The main idea of this theory is based on the following assumptions. First, leaders assess the situation and make strategically important decisions based on their personal vision of the problem, which is formed through experience, values and personal characteristics. In turn, these decisions affect the company's operations in general, and as a result, its financial performance. Secondly, it is almost impossible to obtain psychometric information about the top managers of companies, so scientists agreed that demographic and professional characteristics (age, education, work experience, etc.) can reflect managerial skills and abilities. As practice showed, this point of view is held by a fairly large group of scientists [Carpenter, Geletkanycz, Sanders, 2004; Mackey, 2008].

CEO characteristics and innovations

Many research papers on organizational innovations emphasize that a huge role in innovations development play staff, management and technical experts. Thus, the characteristics of employees and management of a firm have an impact on strategic decisions and critical for people who champion innovations. Champions are people who in fact emerge to promote an innovation activity within organizations because they have an expertise, required resources and other important characteristics to affect the innovation development. It is believed that the role of top management is to influence differently on strategic innovations. It is true that strategic decisions and innovations within the companies are adopted and championed via influence from inside or outside. Thus, the role of top management, and in particular CEO, cannot be underestimated: they are the key actors and champions in the strategic innovation development and are responsible for implementation and development of innovations.

Executives are able to allocate resources, provide vision, structure, guidance and other in order to enhance and speed up innovation development and adoption. At the same time, champions differ from firm to firm. They have different values, leadership style and use a variety of instruments to make an impact. Partly, it is due to some external factors such as culture, but

mostly they differ due to differences in personal treats. Moreover, leadership style and instruments to have an impact champions are likely to differ for each major type of innovation. For instance, product innovations usually benefit more from external factors such as information and marketing expertise, while the process innovations are influenced more by organizational information and internal expertise, but some characteristics of management should be common for all innovation types.

If we look at innovation management from the upper-echelons perspective, CEOs are acting based on their personal understanding of the strategic goals of a company and situations they confront previously. CEOs are the heads and leads of their companies in more ways than one. In fact, CEOs have the power, and even an obligation, to set correct strategic direction of a company and focus the attention of company employees on particular areas of endeavor. To innovate companies should detect the appearance of a new technology and realize some future application for it. Detection, development, formation and adaptation require the knowledge about existing external opportunities and the apprehension of future events. Due to this fact, CEOs attention on events that have not occur yet but may take place and on events that already happen outside the company are predictors of firms' innovativeness.

When CEOs looks in the future and on external organizations, their actions inevitably will reflect this overall strategic focus. CEOs will drive employees' attention to these changes and issues. In turn, this should lead to fastening the detection by the company of new technological opportunities and innovations. A greater attention to possible events that may have an impact of company functioning also leads to greater mobility and preparedness for these events in the future, enabling faster and more effective development and deployment of innovations.

Many researchers have studied CEO characteristics as a significant factor that determines firm performance, because CEOs have different previous experience, tenure, education, skills, knowledge and business judgment. However, previous studies have revealed conflicting results [Lefebvre, Lefebvre 1992; Lefebvre et al. 1997; Papadakis; Khurana 2002; Yadav et al. 2007].

Some researchers have stated that CEOs overall have a positive relationship with firm's financial performance and innovations, whereas others suggests that CEOs tend to miss disruptive technologies due to the fact that they tend to focus on daily business activities, but not on innovation development, the results of which are unclear [Yadav et al. 2007]. At the same time, taking into account these conflicting results, the literature confirms that CEO has a strong effect on firm innovativeness [Papadakis and Bourantas 1998; Yadav et al. 2007].

1.3 CEO characteristics and firm innovativeness in pharmaceutical industry: hypotheses statement

Interest for innovative development in pharmaceutical industry shows that technology, product and process innovations and fast adaptation to changing environment are crucial factors of companies' success. Research papers on pharmaceutical innovation from managerial and organizational points of view highlight a close relationship between extend and speed of technological change and strategy of a company.

In fact, process of innovations development in company is a mix of social, organization, political, economic and management factors. In this list of factors the role of management and, in particular, CEO cannot be underestimated. The choice of management team and CEO may radically change the way company operates, its values, goals and short-term, long-term objectives.

Company that wants to innovate requires a champion: the strong leader who will understand the value and importance of innovations push forward organizational level changes and extend the benefits inside companies [Smith, 2007]. Even though companies may not withstand technological development, they may withstand the changes involved [Schein, 1985]. For all companies in pharmaceutical industry it is important to know CEO with which characteristics innovate more. Thus, it this research paper a list of hypotheses was stated.

The first hypothesis is related with the age of CEO. The older CEO becomes, the more knowledge and skills he or she acquires due to gained experience and trainings. Undoubtedly, this experience is valuable to the company and the older CEO becomes, the more efficient he or she could be in solving daily tasks. Nevertheless, older managers not only tend to have less physical and mental stamina [Child, 1974], but also have less ability to discover new ideas, methods of their application and new behaviors. These actions are linked with ability to innovate and think creatively. Also, the older CEO becomes, the more information he or she seeks before making decision and the longer it takes to make decisions, whereas young CEO have greater abilities and determination in making decisions faster and with confidence [Taylor, 1975].

Different researches have analyzed the role of CEO age. Reinganum found that an older CEO usually not interested in investing into new product development despite of it succeeds is strengthening its market position [Reinganum, 1983]. Marshall also found that the CEO age is important for innovations development: the older he or she is, the more he or she rely on their own information sources when they make decisions, and less likely to take risks [Marchall,

2006]. Jovanovic argues that older CEOs usually less dependent on external conditions and rely on their own knowledge and fields of expertise [Jovanovic, 2001]. Barker & Muller also have analyzed the relationship between CEO characteristics and innovativeness that is measured by R&D expenditures and argued that CEOs who is younger is positively correlated with R&D investment [Barker & Muller 2002]. Similar results were obtained by some other researchers [Yan Yong-hai, 2010].

Moreover, for older managers, it is very important to be financially secured and to have clear career path. Hence, older CEOs may avoid risky actions that could undermine this security. On contrary, younger CEOs tend to be less risk-averse. Thus, the younger CEO is, the more likely he or she will pursue innovative and risky strategies. Companies where CEOs are young are able to go through the risky changes and actions needed to succeed in unstable and changing environment.

Due to these facts, firms with younger CEOs will probably have higher growth and variability in profitability in comparison with industry averages, relative to firms with older CEOs. Moreover, because risk is linked with innovations, it could be expected that firms with younger CEO will be more innovative in terms of number of new patents and R&D spending. Thus, it is expected that the younger CEO in pharmaceutical industry is, the more innovative company is: R&D expenditures are higher and number of patents is more than in company where CEO is older. Thus, the first hypothesis was formulated:

H1. CEO age negatively relates to the company innovativeness.

A CEOs' educational level: whether he or she has received bachelor's, master's or doctoral degree influences on strategy planning skills and also contributes to the readiness and openness of firm to change [Classen et al., 2012]. At high level, the higher degree of education is, the higher is the ability to identify and apply an external knowledge that are essential for absorptive ability and capacity [Roach and Sauermann, 2010]. Using developed through education analytical skills and strong information processing ability CEOs who received master's and PhD are able to weight a lot of information simultaneously. Because innovations development is complex process, a CEO who can faster process a lot if information flows will enable a company to detect and manage the knowledge that will in turn increase the strong absorptive capacity and establish an atmosphere for innovations development.

Lin et al have analyzed the relationship between CEO characteristics and innovativeness that is measured by R&D expenditures. Their results supported the statement that CEO

educational level is positively related to firm innovation efforts [Lin et al, 2009]. Wen Fang et al claim that educational level of CEO has significant and positive relationship with R&D spending [Wen Fang et al 2009].

Also, CEOs who acquired wide set of knowledge and has developed skills during their studies inevitably becomes more knowledgeable on innovation, or in processes that can be useful for innovation development. Highly educated CEOs are in favor of innovation and are able to give relevant advice on decisions. Some researchers claim that the advanced master's and PhD level of CEOs education improves their assessment of the firm's R&D activities. CEOs with such background have knowledge on innovation management and thus are able to advise and manage successfully an innovation processes in company. Apart from this, directors with master's and PhD educational levels usually are aware of new technologies and trends, which is useful for innovation management [Lin, Lin, Song, & Li, 2011].It may be suggested that master's and doctoral degree corresponds to higher innovativeness than if CEO received only bachelor degree. The second hypotheses can be formulated.

H2. Innovativeness of companies where CEO has received master's or doctoral degree is higher than innovativeness of companies where CEO did not receive such degrees.

Companies that want to innovate and adapt approaches for innovative development through better understanding and absorbing information may consider appointing CEOs with engineering or medical educational background. Some researchers claim that directors' technical skills and knowledge is positively related to R&D costs [Dalziel et al. 2011]. Pharmaceutical firms may want to appoint directors with an engineering background, because such CEOs are usually in trend with recently introduced technology, needs of consumer, supplier capabilities and governmental regulations [Chen, 2014]. Thus, they have a better insight into emerging opportunities and are able to adapt them faster. CEOs with knowledge and experience in medical research may also be demanded since innovations in pharmacy require specific knowledge of industry and products. That is especially important when it is product innovation: improvements in recipes, components, or new treatment method.

On contrary, CEO's economic expertise is undoubtedly valuable for the company overall: is leads to effective planning and controlling processes in a vast scope of fields. They have a deep understanding of all procedures within a company, accurately develop budgets, and control financial reports. However, a CEO's economic background usually leads to cost cutting that may be less favorable for innovative projects, that requires considerable investments and assumed to

be highly risky. Some researchers claim that the CEO's economic expertise is negatively linked to opportunities for growth [Jeanjean, Stolowy 2009]. Education in economics leads to bureaucratic policies appearance, and paying the highest attention to financial reporting instead of developing and adaptation of innovations [Naranjo Gil, Mass, 2009].Thus, it may be expected that if CEO has an education in engineering or medicine innovativeness of company will be higher than in company where CEO has an education in other field.

H3. Innovativeness of companies where CEO has received education in medical or engineering field is higher than innovativeness of companies where CEO is not educated in these fields.

The knowledge that CEO receives due to personal working experience undoubtedly affects the way he or she select and implement strategies. For CEOs who have a deep business expertise and experience, it is much easier and faster to learn about how a company operates which strategy follows and what is done incorrectly. All these factors CEOs take into account when making significant decisions. All gained knowledge and experience enable CEOs to make judgments and offer rational and constructive criticism. Gained professional experience inside or outside the company CEO operates will help to acquire necessary skills that cannot be entirely covered and gained through education. Such findings are supported by some researches [Grazzi M., D. Moschella, 2017].

At the same time, some scientist found that tenure has a negative relationship with company's innovativeness [Lefebvre, 1992]. Zajac and Stearns also claim that CEO tenure has significant negative relationship with R&D expenditures [Zajac & Stearns 1997]. It is explained that a longer tenure corresponds to more habit-based decisions, greater reluctance to change policies and products, and thus smaller likelihood to do radical changes.

Tenure may also be linked with company innovativeness: short tenured CEOs, because of possible lack of experience in industry or on this particular position may not be able to effectively assess strategic risks and opportunity to innovate. On contrary, long tenured CEOs that have accumulated knowledge of the firm's environment may become inflexible in implementing changes when it is risky or when the outcome in unclear.

Wen Fang et al claim that professional experience of CEO has significant and positive relationship with R&D spending [Wen Fang et al 2009]. Liu YunGuo et al analyzed the effect of CEO tenure on R&D. Their results show that R&D expenditure is positively related with CEO tenure [Liu YunGuo et al 2007]. Barker and Muller found that CEO tenure is positively correlated with R&D spending [Barker & Muller 2002].

Overall, it is expected that the longer tenure is, the more innovative company becomes, because CEO may see a field for improvement, access all risk and manage changes effectively. Thus, it may be concluded that in pharmaceutical industry professional experience gained as well as tenure length are positively related with company innovativeness.

H4.1 CEO tenure positively relates to the company innovativeness.

H4.2 CEO industry experience positively relates to the company innovativeness.

In various industries, networks of directors may help enforce contracts and overcome market inefficiency. Members of the networks usually share similar backgrounds or experience and feel committed to their networks. The networks help to share useful information about trends and dynamics in industries: productive resource and knowledge exchanges bring support to innovation. When they have wide business knowledge, directors may acquire new skills and objectivity [Kesner, 1988]. Business connections contribute to building useful capabilities for innovative companies through joint ventures creation and technology transfer [Markarian&Parbonetti, 2007]. When information is acquired from CEOs' is usually considered to be more reliable [Lynall, Golden, & Hillman, 2003]. Palmer and Barber claimed that the bigger director's network is, the more probably company will be innovative [Palmer & Barber 2001]. Directors' interconnections give a better view of the sustainability of R&D activities because various issues are usually the same in other companies and also that they know organizations that have already succeeded. In addition, R&D and new patents development require considerable investments where CEOs' network can help find extra financial support, access necessary resources, which could compensate company's limited capabilities. For all aforementioned reasons, it may be expected that the size of network of directors positively relates to the company innovativeness.

H5. The size of network of directors and interlocks with various industries positively relates to the company innovativeness.

The structure of CEO compensation is constantly evolving and changing and often depends on current economic and political situation. Nevertheless, amount of total remuneration as well as the usage of various compensation elements follows trends over the time. The base salary is a fixed amount that CEO will get regardless of the company financial performance and actions that has been done over the period. Thus, the fixed payment should not motivate the CEO to act effectively and put the efforts to increase company performance. Respectively, only a part

of CEO remuneration is fixed: CEOs usually receives bonuses as payoffs that depend on annual firm performance and often measures based on financial results of a company. This means that a considerable part of CEO compensation tied with company performance [Lerner and Wulf, 2007; Francis, Bill & Hasan, 2011].

Some may argue that such dependence of performance may motivate the CEO to manage earnings in a way to improve it only in short-term instead of long-term value creation. However, especially if the CEO contract is not time-limited focusing only on short-term is not rational decision. In addition to this, it may be claimed that such payment structure affect the risk-taking behavior of CEO in favor of avoiding risky business decisions. Shim et al found strong relationship between CEO total compensation and company innovativeness [Shim et al 2009]. However, in pharmaceutical industry it is clear that implemented innovations are crucial for company long-term development. Thus, CEOs realize the importance of it for company and respectively for remuneration. It may be concluded that the fixed part of the salary is unlikely to motivate CEO to follow innovation strategy, and is not significant, while total remuneration positively relates with company innovativeness.

H6.1 The size of fixed compensation negatively relates to company innovativeness.

H6.2 The size of total compensation positively relates to company innovativeness.

In general, there is no excessive performance advantage between CEO that has been promoted from inside or from outside — CEOs with both the most outstanding and lowest performance may come from each category. However, it could not be said that it do not matter whether a company appoint a CEO from the inside or outside. Some studies found that CEOs are appointed from inside much more frequently than outsiders when company has a stable financial situation, while in challenged companies CEOs are highbred from outside more frequently. At the same time, statistic shows that performance of insider is slightly higher that performance of outsider. As for innovations, CEO that has been promoted from the position inside may feel more committed to the company and know better the field for improvements as well as where to innovate. Such positive effect has been found by some researchers [Balsmeier, Buchwald, 2015; Giambatista et al., 2005; King & Anderson, 1990]. Thus, in can be expected that innovativeness of companies where CEO was promoted from the position inside the company is higher than innovativeness of companies where CEO is outsider.

H7. Innovativeness of companies where CEO was promoted from the position inside the company is higher than innovativeness of companies where CEO is outsider.

Chapter 2. Empirical study

2.1 Research methodology

The research is based on analyzing the information about European public pharmaceutical companies. As it has been stated before the main research goal of this paper is to analyze how different CEO characteristics are connected with innovativeness of the public pharmaceutical companies in European Union.

The analysis is econometrics modeling. Similar technique has been used in various papers that aims to identify the relationship of CEO characteristics and innovative characteristics of companies [Hsien-Chang Kuo, Lie-Huey Wang 2017; Allemand I..Brullebaut B., Galia F., Zenou E., 2017; Chen, H. L. 2014]. Models have been tested in R studio, an integrated development environment for R.

For this research, secondary data is collected. The information about R&D, revenue is gathered from Tomson Reuters Database and annual reports. Information about CEOs is collected from annual reports, Bloomberg profiles and companies websites. Data about firm age is taken from companies' websites.

In this research, the next variables will be used:

Table 1.Description of variables

	Variable	Description
Independent variables	Age	The age of the CEO at the end of a fiscal year. Calculated as the observed year minus the year of CEO birth
	Master	The variable shows if an executive has obtained master degree. 1 – has obtained, 0 – otherwise.
	Doctor	The variable shows if an executive has obtained doctorate degree. 1 – has obtained, 0 – otherwise.
	MBA	The variable shows if an executive has obtained MBA degree.

		1 – has obtained, 0 – otherwise.
	Med	The variable shows if an executive has obtained education in chemistry/biology/medicine 1 – has obtained, 0 – otherwise.
	Engineer	The variable shows if an executive has obtained education in engendering 1 – has obtained, 0 – otherwise.
	Econom	The variable shows if an executive has obtained education in economics 1 – has obtained, 0 – otherwise.
	Experience	The variable shows a number of years CEO is working in pharmaceutical industry
	Tenure	The variable shows a number of years on the CEO position in the company at the end of a fiscal year rounded. Calculated as a number of observable year minus year when CEO has been appointed to the position
	Insider	The variable shows whether CEO was appointed from another position within the company 1 – from inside, 0 – from outside.
	Network.dir	Number of executive managers with whom CEO has been working with Calculated as a number of directors with whom CEO has been working with
	Network.ind	Number of industries where executives from CEO network have been working Calculated as a number of industries where

		directors, whom CEO know, are working
	Fixed.comp	The amount paid to the CEO on the fixed basis in observable year Calculated as fixed compensation in observed year
	Total.comp	The total amount paid to the CEO in observable year Calculated as total compensation received by CEO in observed year
	Variable	The share of variable part of a compensation in total remuneration Calculated as the difference between total CEO remuneration and its fixed part divided by total amount of remuneration in observed year
Dependent variables	R.D.Exp	The variable shows R&D expenditures in observed year Calculated as a logarithm of R&D expenditures in observed year
	NewPatents	The variable shows the number of patents received in observable year
Control variables	Firm.age	A proxy variable for firm age, calculated as observable year minus year of company foundation rounded
Company size	Revenue	A proxy variable for firm size, based on firm's revenue in the end of the year Calculated as a logarithm of Revenue in the end of the year

Source: made by the author

Model for R.D.Exp

Variable **R.D.Exp** is analyzed by using linear regression **without time lag**, because the CEO characteristics have immediate effect on amount of R&D expenditures.

$$y_i = \alpha + \beta_1 CEO_i + \beta_2 control\_variable_i + \varepsilon_i$$

In this equation y_i, represents the dependent variable R.D.Exp counted for i[th] observation, α is an unknown scalar quantity, the regression intercept, β_1, β_2 – vectors of coefficients in a modeled linear regression, $CEO_i, control\_variable_i$ – independent and control variables for i[th] observations, $\varepsilon_i$is a random error term that appears due to existence of other factors that are not included in the model.

Model for NewPatents

Variable **NewPatents** is analyzed by linear regression **with 2 and 3 years time lag,** because the CEO characteristics do not have immediate effect on number of new patents per year. For example, in model with time lag = 3, CEO characteristics in 2009 are analyzed to have relationship with the number of new patents in 2012.

$$y_i = \alpha + \beta_1 CEO_{i-lag} + \beta_2 control\_variable_{i-lag} + \varepsilon_i$$

In this equation y_i, represents the dependent variable counted for i[th] observation, α is an unknown scalar quantity, the regression intercept, β_1, β_2 – vectors of coefficients in a modeled linear regression, $CEO_{i-lag}, control\_variable_{i-lag}$ – independent and control variables for i[th] observations, $\varepsilon_i$is a random error term that appears due to existence of other factors that are not included in the model.

The data gathered is a panel data. This means that for regression analysis a several regression modes can be chosen:

- The pooled model. This model is based on assumption that there are neither unique characteristics of individuals within the set, nor universal effects over time. The intercept and the slope coefficients are constant across time and objects, and the random error term captures these differences over objects and time.
- The fixed model. Model implies that there are some unique characteristics of individuals and they are constant. These characteristics may have an impact on the predictor or outcome variables and model aims to control for this. The slope coefficients are constant but the intercept varies over objects.

- The random effects model. This model is based on the assumption that there are some unique, constant over the time characteristics and they are not correlated individual repressors. The slope coefficients in this model are constant but intercept varies over objects and time.

To make sure that chosen model is appropriate several tests should be conducted. All models were tested on all three regressions. All three models were created using R instruments.

First, the panel model was build based on initial dataset. Because some cells were empty due to lack of data, they were remained from the final dataset. Company number (ID) and year of observations (Year) – are indexes based on which the panel model was build. After this, all three models were created using R instruments and after test to determine whether one model or another is better was conducted:

- Lagrange Multiplier Test for random effects versus pooled was conducted. The result showed that random effects model is better than pooled.
- F test for individual effects showed that there are significant fixed effects and that this model is better that pooled.
- Hausman Test was used to determine what model is better: with fixed effects or with random. Result showed that the model with fixed effects should be used in further analysis.

To sum up, the **model with fixed effects** should be used in panel data on pharmaceutical companies' analysis.

2.2 Data and sample

The data is gathered for public pharmaceutical companies registered in European Union. The sample includes 55 companies (out of 65 public pharmaceutical companies in EU) for which all needed data for the 8 years from 2009 to 2016 was available.

EU pharmaceutical public companies present different countries, but some of countries are leaders in number of public pharmaceutical companies, while other do not have them at all. Sample for research includes 55 companies from 19 countries (Figure 4).

Figure 4 Map of countries where companies from sample locate.

Source: made by the author

The biggest number of public companies are located in United Kingdom, where 13 pharmaceutical companies are based. The second biggest number of public pharmaceutical companies is in France: 8 companies. The third country in the list is Germany, with 7 companies.

Table 2. List of countries where companies from sample locates

Number of a country	Country	Number of public pharmaceutical companies
1	United Kingdom	13
2	France	8
3	Germany	7
4	Denmark	4
5	Romania	3
6	Spain	3
7	Bulgaria	2
8	Ireland	2
9	Italy	2
10	Sweden	2

11	Belgium	1
12	Croatia	1
13	Cyprus	1
14	Finland	1
15	Hungary	1
16	Latvia	1
17	Poland	1
18	Portugal	1
19	Slovenia	1

Source: made by the author

Some of the companies in sample have been controlled by families for generations: the executive board manly consists of members of one family. At the same time, majority of companies in sample are not family-owned. The average age of a company in dataset is 61. That could be explained that it usually takes long from the moment of company foundation to the moment of IPO.

Before conduction of the regression analysis, aiming to research connections between characteristics of CEO and innovativeness of the company, the descriptive analysis was performed.

Table 3.Descriptive statistics of dependent variables

Dependent Variable	Mean	Median	St. Deviation	Min	Max
R.D.Exp	439904.0000	16512.0000	1144717.00000	2.00000	5450000.0000
NewPatents	4.5350	0.0000	9.38083	0.00000	77.0000

Source: made by the author

Based on the descriptive analysis of dependent variables it can be said that the spread of the indicators is very high for R&D expenditures in absolute value, while for new patents, the spread is much smaller. As a result, the variables should be analyzed taking into account the size of the company as well.

Descriptive analysis for independent variables descriptive statistics are presented below:

Table 4.Descriptive statistics of independent variables

Independent Variable	Mean	Median	St. Deviation	Min	Max
Age	53.840	54.000	7.056	35.000	72.000
Master	0.640	1.000	0.481	0.000	1.000
Doctor	0.321	0.000	0.467	0.000	1.000
MBA	0.212	0.000	0.409	0.000	1.000
Med	0.358	0.000	0.480	0.000	1.000
Engineer	0.151	0.000	0.358	0.000	1.000
Econom	0.476	0.000	0.500	0.000	1.000
Experience	24.430	25.000	9.347	1.000	50.000
Tenure	6.869	5.000	6.385	1.000	48.000
Insider	0.533	1.000	0.500	0.000	1.000
Network.dir	18.660	7.500	26.305	0.000	142.000
Network.ind	4.044	3.000	4.024	0.000	20.000
Fixed.comp	493.200	308.000	455.412	28.000	3014.000
Total.comp	1690.000	515.000	3144.029	39.000	26451.000
Variable	0.453	0.431	0.268	0.007	3.363

Source: made by the author

In general, the spread of the indicators is relatively low for majority of variables. An exception is high spread for fixed and total compensation. It may be suggested that these variables are highly dependent on the size of the company: the bigger company is, the higher CEO remuneration may be expected. A vast majority of CEOs are man (96%), 54 years old, in 64% cases CEO has a master degree, in 32% a doctoral degree, in 21% received MBA. 48% of CEOs in the sample received degree in Economics, 36% received degree in medicine, pharmacy or related studies, 15% received degree in engineering. In general, CEOs have been working in pharmaceutical industry for 24-25 years and occupy the CEO position for 7 years. In 53% CEO was hired on this position from inside. The size of network for CEOs vary a lot, but in general

the network is 18 directors from 4 various industries. Fixed and total compensations significantly differs across all companies in the sample, but the median is 308 fixed, 515 total.

Based on descriptive statistics above the average portrait of CEO can be created. The average CEO in pharmaceutical industry is 54 years old man, has obtained Master degree in Economics. Before becoming a CEO he has been working in pharmaceutical industry around 24 years. He has occupied current CEO position for 7 years after working in current company for some time. Most probably, he will be connected with 18 directors across 4 different industries. Fixed compensation highly depends on company, but in average (mean) he receives 308 thousands euro per year. Total compensation includes fixed and variable parts, where variable part is 45% of the fixed one.

For control variables the descriptive statistics are presented below:

Table 5.Descriptive analysis of control variables

Control Variables	Mean	Median	St. Deviation	Min	Max
Revenue	3567954.000	269871.000	8812403.000	12.000	46670473.000
Firm.age	65.960	47.000	7.056	1.000	349.000

Source: made by the author

As it can be seen, the age of a companies' vary significantly: from 1 year from foundation moment to 349 years. The same can be said about revenue, but in absolute terms it vary much more: from 12 to 46 670 473 thousand euros. Thus, both variables may have a moderation effect of regressions so that all influence should be checked.

In order to clarify that variables are do not have any relationship, connection, or interdependence between each other the correlation matrix has been analyzed (Table 6). The highest correlation have variables Experience and Age. It could be explained by the fact that there are many CEOs who have been working in industry starting from their graduation from university. At the same time, correlation as not extremely high: some CEOs come to pharmacy from other industries such as consulting. Also, in hypotheses that have been stated different effect from variables Experience and Age is expected: negative for age and positive for experience. This fact supports the idea that both variables should remain included in the sample.

Table 6. Correlation matrix

	Year	New Patents	R.D.exp	Age	Gender	Master	Doctor	MBA	Med	Econom	Engineer
Year	1,00	0,10	0,04	0,17	0,00	-0,04	-0,04	0,08	-0,01	0,04	-0,05
NewPatents	0,10	1,00	0,03	0,18	-0,07	-0,02	-0,01	0,11	0,05	0,00	0,04
R.D.exp	0,04	0,03	1,00	0,07	-0,07	-0,10	0,02	-0,03	0,00	0,05	-0,11
Age	0,17	0,18	0,07	1,00	-0,15	0,05	0,05	0,13	0,22	0,03	-0,14
Gender	0,00	-0,07	-0,07	-0,15	1,00	-0,05	0,07	0,15	0,07	0,01	-0,08
Master	-0,04	-0,02	-0,10	0,05	-0,05	1,00	0,34	-0,08	0,34	-0,31	0,04
Doctor	-0,04	-0,01	0,02	0,05	0,07	0,34	1,00	-0,02	0,17	-0,24	-0,04
MBA	0,08	0,11	-0,03	0,13	0,15	-0,08	-0,02	1,00	0,22	0,05	0,23
Med	-0,01	0,05	0,00	0,22	0,07	0,34	0,17	0,22	1,00	-0,38	-0,13
Econom	0,04	0,00	0,05	0,03	0,01	-0,31	-0,24	0,05	-0,38	1,00	-0,30
Engineer	-0,05	0,04	-0,11	-0,14	-0,08	0,04	-0,04	0,23	-0,13	-0,30	1,00
Experience	0,14	0,22	0,14	0,42	-0,02	-0,14	-0,03	0,00	0,06	-0,01	-0,26
Tenure	0,08	-0,05	-0,09	0,26	-0,09	0,17	0,17	-0,01	0,04	-0,10	-0,15
Network.dir	-0,05	0,40	0,13	0,05	0,04	-0,07	0,04	0,08	0,19	-0,24	-0,05
Network.ind	-0,02	0,41	0,35	0,09	-0,08	0,05	0,08	0,09	0,14	-0,10	-0,03
Insider	-0,03	0,07	-0,06	-0,05	-0,01	0,00	-0,02	-0,17	-0,13	-0,13	0,03
Fixed.comp	0,14	0,04	0,61	0,12	-0,09	-0,09	0,08	0,15	0,18	-0,09	-0,07
Total.comp	0,13	-0,04	0,45	0,10	-0,08	-0,05	0,14	0,15	0,07	-0,04	-0,06
Variable	0,05	0,12	0,44	0,16	-0,06	-0,11	0,03	0,04	-0,01	0,13	-0,02
Revenue	0,03	0,07	0,96	0,09	-0,08	-0,09	0,04	-0,05	0,01	0,05	-0,10
Firm,age	0,03	0,24	0,45	0,21	-0,09	0,00	0,13	-0,03	0,02	0,03	0,00

	Experience	Tenure	Network. dir	Network. ind	Insider	Fixed. comp	Total. comp	Variable	Revenue	Firm age
Year	0,14	0,08	-0,05	-0,02	-0,03	0,14	0,13	0,05	0,03	0,03
NewPatents	0,22	-0,05	0,40	0,41	0,07	0,04	-0,04	0,12	0,07	0,24
R.D.exp	0,14	-0,09	0,13	0,35	-0,06	0,61	0,45	0,44	0,96	0,45
Age	0,42	0,26	0,05	0,09	-0,05	0,12	0,10	0,16	0,09	0,21
Gender	-0,02	-0,09	0,04	-0,08	-0,01	-0,09	-0,08	-0,06	-0,08	-0,09
Master	-0,14	0,17	-0,07	0,05	0,00	-0,09	-0,05	-0,11	-0,09	0,00
Doctor	-0,03	0,17	0,04	0,08	-0,02	0,08	0,14	0,03	0,04	0,13
MBA	0,00	-0,01	0,08	0,09	-0,17	0,15	0,15	0,04	-0,05	-0,03
Med	0,06	0,04	0,19	0,14	-0,13	0,18	0,07	-0,01	0,01	0,02
Econom	-0,01	-0,10	-0,24	-0,10	-0,13	-0,09	-0,04	0,13	0,05	0,03
Engineer	-0,26	-0,15	-0,05	-0,03	0,03	-0,07	-0,06	-0,02	-0,10	0,00
Experience	1,00	0,26	0,22	0,11	0,24	0,21	0,19	0,27	0,15	0,21
Tenure	0,26	1,00	0,01	-0,18	0,22	-0,16	-0,11	-0,12	-0,10	0,05
Network.dir	0,22	0,01	1,00	0,57	0,09	0,11	0,18	0,21	0,13	0,04
Network.ind	0,11	-0,18	0,57	1,00	-0,17	0,22	0,20	0,27	0,39	0,14
Insider	0,24	0,22	0,09	-0,17	1,00	0,08	0,08	0,10	-0,04	0,15
Fixed.comp	0,21	-0,16	0,11	0,22	0,08	1,00	0,81	0,58	0,57	0,45
Total.comp	0,19	-0,11	0,18	0,20	0,08	0,81	1,00	0,64	0,40	0,27
Variable	0,27	-0,12	0,21	0,27	0,10	0,58	0,64	1,00	0,44	0,41
Revenue	0,15	-0,10	0,13	0,39	-0,04	0,57	0,40	0,44	1,00	0,49
Firm,age	0,21	0,05	0,04	0,14	0,15	0,45	0,27	0,41	0,49	1,00

Source: made by the author

2.3 Empirical results

The models analyzed were based on the CEOs characteristics and their influence on the innovativeness of the company. Innovativeness is measured as yearly R&D expenditures and new patents received over observed year (from 2009 to 2016 year).

Models for CEOs characteristics relationship with patents received were build using 2 and 3 years time lag, because it is assumed that new patents in pharmaceutical industry are

developing for a long time, not in one year. Model for R&D expenditures was built without time lag.

The estimated coefficients for all independent and control variables importance in all three models are presented in the table below.

Table 7.Results of regressions with Fixed effects

	R.D.Exp	NewPatents (lag=2)	NewPatents (lag=3)
	Pr(>|t|)	Pr(>|t|)	Pr(>|t|)
XAge	0.658926	3.072e-10***	4.754e-07***
XMaster	0.836263	0.0031581**	1.735e-06***
XDoctor	0.772852	0.1198090	0.034703*
XMBA	7.999e-0.5***	0.0219857*	0.006522**
XMed	0.068528.	0.0354326*	0.885968
XEconom	0.022830*	0.0009382***	1.511e-10***
XEngineer	0.148156	0.1057703	0.555968
XExperience	0.266943	3.625e-11***	2.929e-05***
XTenure	0.225946	0.2623981	0.233936
XNetwork.dir	0.065838.	0.0049149**	<2.2e-16***
XNetwork.ind	0.004894**	0.5259903	0.305312
XInsider	0.017199*	0.0002319***	0.002078**
XFixed.comp	0.161227	0.6143493	0.014813*
XTotal.comp	8.297e-05***	0.9983594	0.011744*
XVariable	0.377104	0.7987580	0.596861
XRevenue	0.050744.	<2.2e-16***	6.395e-14***
XFirm.age	0.005511**	0.0002183***	0.018615*
F-statistic:	16.8 on 17 and 387 DF	5.2 on 17 and 297	8.6 on 17 and 250

p-value	<2.22e-16	DF	DF
R-Squared	0.42501	6.1832e-10	<2.22e-16
Adj. R-Squared	0.31655	0.46791	0.67185
		0.36545	0.60464

Source: made by the author

Significance levels:

‘***’ significant at 0 level

‘**’ significant at 0.001 level

‘*’ significant at 0.01 level

‘.’ significant at 0.05 level

The models show that age of CEO has a strong negative relationship with a number of new patents obtained in both models: with lag 2 and with lag 3. This variable has the highest level of significance. At the same time, this variable is not significant for amount of R&D spending that means that R&D expenditures are not connected with the age of CEO.

As for CEO education, it could be said that received MBA degree has a strong positive relationship with R&D expenditures with the highest level of significance. At the same time, the relationship with number of new patents is slightly weaker, but also remains positive: 0.001 level of significance for model with lag 2 and 0.01 level of significance for model with lag 3. Master degree is significant for number of new patents obtained in both models (with lag 2 and 3) and relates to it positively. Doctoral degree has positive effect on number of patents obtained in model with lag 3 and no not have any effect for other models.

Education of CEO is also important factor for all three models. All three models show has strong negative effect an education in economics that means that companies innovate less is CEO received education in this field. Education in medicine significant and has shown positive relationship in models for R&D expenditures and number of patents with lag 2, however the level of significance is 0.1 and 0.05 respectively. CEOs education in engineering is not an important factor in all three models.

CEO experience in pharmaceutical industry has strong positive relationship with innovation characteristics in models for number of new patents obtained: variable is significant with a highest level of significance, however in model for R&D this variable is not significant. Tenure is not important for all three models.

The size of director's network that shows the number of directors whom CEO knows is significant and has a positive relationship with innovativeness in all three models: for R&D expenditures the level of significance is 0.5, for new patents obtained with lag 2 and lag 3 the levels of significance are 0.001 and 0 respectively. Network of CEO within different industries positively significant only for R&D expenditures model: the level of significance is 0.001.

The variable that shows that CEO was promoted from the position inside the company is significant for all three models with 0.01, 0 and 0.001 levels of significance respectively. This variable is positive in all three models.

The size of base salary, or fixed compensation, is negatively significant in model for amount of R&D expenditures. For other models, this variable is not significant. At the same time, total compensation has a strong positive relationship with R&D spending with a 0 level of significance and has positive relationship with number of new patents in model with lag 3.

Control variables: revenue and firm age significant in all three models.

All three models are overall significant: p value for all models is smaller than 0.05.

2.4 Findings and discussions

The goal of the study was to identify the relationship between CEO characteristics and innovativeness of the public pharmaceutical companies in European Union measured by R&D expenditures and number of new patents obtained. This relationship has been tested by using econometric modeling on 55 public pharmaceutical companies in EU from 2009 to 2016 year. Based on empirical analysis it is possible to derive conclusions.

Primarily, the conclusions are drawn based on the hypotheses that have been stated in this research. Below in the tables you can see whether hypothesis was accepted or not.

Table 8. Comparison of hypotheses with obtained results: could hypothesis be accepted or not

Hypothesis	Result for R&D model	Result for new patents model with lag 2	Result for new patents model with lag 3
H1. CEO age negatively relates to the company innovativeness.	Cannot be neither supported nor rejected	Accepted	Accepted
H2. Innovativeness of companies	Accepted	Accepted	Accepted

where CEO has received master's or doctoral degree is higher than innovativeness of companies where CEO did not receive such degrees.			
H3. Innovativeness of companies where CEO has received education in medical or engineering field is higher than innovativeness of companies where CEO is educated in other field.	Accepted	Accepted	Accepted
H4.1 CEO tenure positively relates to the company innovativeness.	Cannot be neither supported nor rejected	Cannot be neither supported nor rejected	Cannot be neither supported nor rejected
H4.2 CEO industry experience positively relates to the company innovativeness.	Cannot be neither supported nor rejected	Accepted	Accepted
H5. The size of network of directors and interlocks with various industries positively relates to the company innovativeness.	Cannot be neither supported nor rejected	Accepted	Accepted
H6.1 The size of fixed compensation negatively relates with company innovativeness.	Cannot be neither supported nor rejected	Cannot be neither supported nor rejected	Accepted
H6.2 The size of total compensation positively relates with company innovativeness.	Accepted	Cannot be neither supported nor rejected	Accepted

H7. Innovativeness of companies where CEO was promoted from the position inside the company is higher than innovativeness of companies where CEO is outsider.	Accepted	Accepted	Accepted

Source: made by the author

On the one hand, CEO age has a relationship with number of patents that are obtained by companies, but on the other hand, this variable is not significant for R&D expenditures. It can me assumed, that when CEO is younger, he or she manages effectively all R&D efforts that further leads to new patents obtaining: it could be either the right choice of field of R&D efforts or effective support and management of R&D department. Thus, it could be said that CEO age negatively relates to the company innovativeness.

In general, companies innovate more if CEO has received masters or doctoral degree than if CEO has received only bachelor degree. Among all three variables: master's degree, MBA and doctoral degree the most significant one is MBA degree, being significant for all three regression models. Masters degree significant only for new patents obtained and doctoral is significant for new patents model with lag 3. In general, it means that company spends more on R&D if CEO has master's degree and receives more new patents if CEO has either master's of doctoral degree. It may be assumed that it is so because CEOs who acquired wide set of knowledge and has developed skills during their studies becomes more knowledgeable on innovations and consequently innovate more than other CEOs with only bachelor's degree.

The education in medical or engineering field did not show a consistent relationship with R&D spending and number of new patents obtained with one exception: medical education is important for model for new patents with lag 2. At the same time, the fact whether CEO has an education in economics or not is important for all models: all of them showed that if CEO is educated in this field, company is innovating less. The most reasonable explanation of this fact is that CEOs with background in economics are concerned primarily about financial indicators, tend to avoid risky investments and usually follow a cost cutting strategy that may be less favorable for innovations development.

CEO tenure does not show influence on company innovativeness: being insignificant for all models. At the same time, industry experience has positive relationship with the number of patents received. It can be assumed that the important factor is that whether CEO has a relevant

experience in pharmaceutical industry, but not the number of years spent in CEO position: gained professional experience either inside or outside the company will help to acquire valuable skills that cannot be entirely covered and gained only through education.

Director's size of network determined by number of total interlocks among all industries does not show relationship with R&D spending, but shows influence on the number of new patents obtained. At the same time, number of industries where directors work are important for amount of R&D spending but does not show a relationship with a number of new patents received. These controversial results could be explained in the next way: the total size of director's network positively relates to company innovativeness and lead to increasing number of patents. All director's connections contribute to joint ventures creation, technology transfer as well as to receiving a better view of strategies for R&D investments and knowing the key of success based on experience of other directors. Thus, the bigger the network is, the more patents in average company will receive in 2, 3 year-period.

The fixed compensation does not show a strong influence, being significant only for number of new patents received with lag 2. At the same time, for this model variable has negative effect that supports the hypothesis. On contrary, the size of total compensation has a relationship with company innovativeness being significant for R&D spending and for one of the models for new patents. That means that the more CEO receives in absolute values, the more innovative company is. It could be implied that CEOs in pharmaceutical industry are aware of innovations role in company development, and realize that the more they will innovate, the bigger remuneration they will receive. It may be concluded that the hypothesis about fixed part role can be neither supported, nor rejected, while it could be said that total remuneration positively relates with company innovativeness.

Innovativeness of companies where CEO was promoted from the position inside the company shows consistent significant influence on all dependent variables. It could be inferred that if CEO has been promoted from the position inside he or she may feel more committed to the company and know better the where the processes and products should be improved as well as where to innovate. Thus, it can be said that innovativeness of companies where CEO was promoted from the position inside the company is higher than innovativeness of companies where CEO is outsider.

2.5 Managerial implications

Companies' growth and development in pharmaceutical industry is driven by innovations. Different factors that can predetermine the innovative development is among the most researched topics nowadays. One of the factors that can play role in innovative development is CEO characteristics.

Companies are interested in this in particular when they should choose and assign new manager on executive position. They tend to analyze how the candidate will fit to the company, what actions may be predicted and expected, what is his or her psychological portrait, etc. Especially it is important when company choose who will become a new CEO. CEO is the main executive in a company. The primary responsibility of CEO is to make major corporate decisions, to plan and manage all high-level operations of a company and to communicate between the board of directors and corporate operations. That is why company pays so much attention when decide who will become a new CEO.

Researches usually use as a CEO characteristics his or her age, gender, education, experience, network. At the same time, it could not be said that there is a perfect portrait of CEO for all companies in all industries. In fact, each industry has its own specifics and companies in different industries should be led by CEO with some special "perfect portrait". Pharmaceutical industry is not an exception: it has a lot of specifics that distinguish this industry from others. Results of this research have not only theoretical contribution in the existing line of research, but also imply useful managerial implications for companies in pharmaceutical industry.

This research is expected to attract attention to the CEO characteristics before he or she is assigned to the CEO position in the company. The results of empirical analysis shows that different CEO characteristics have various relationships with company innovativeness, measured by R&D spending and number of new patents obtained. Thus, personal CEO characteristics should be taken into consideration when assigning new CEO.

When assigning a new CEO company should pay attention on several characteristics:

CEO age. The younger CEO is, the more new patents company receives in next 2 and 3 years. Thus, while choosing among younger and older candidate to CEO position with similar characteristic, company should prefer the younger one.

CEO field of education. If candidate to CEO position received education in economics, company will innovate less. Thus, if the company wants to innovate more, is should avoid assigning a director with background in economics.

CEO level of education. If candidate received master's and doctoral level of education, company will innovate more. While choosing among candidate with master's or doctoral degree and the one with bachelor degree it is better to prefer the one with master's of doctoral degree.

Experience. The longer candidate is working in pharmaceutical industry, the more patents company receives when candidate became a CEO in company. Thus, it is better to hire candidate with relevant experience.

Personal network. The more directors candidate to CEO position knows, the more innovative company will become. It is preferable to hire director with broad personal network.

Hiring from inside. Study shows that if CEO was promoted from the position inside the company is more innovative that if CEO is outsider. Thus, it is better to hire CEO from inside.

Remuneration. The high total remuneration corresponds to higher company innovativeness. Thus, the absolute amount of compensation does matter.

At the same time, it should be mentioned that these recommendations are rational when company in pharmaceutical industry wants to pursuit the innovative strategy. If the main goal is financial performance, recommendations may change.

2.6 Research limitations

The goal of this research paper was to identify the relationship between CEO characteristics and innovativeness of the public pharmaceutical companies in European Union measured by R&D expenditures and number of new patents obtained. The goal was achieved and research has both theoretical contributions and managerial implications. At the same time, this research has some limitations that can in turn shape the direction of future research.

The first limitation is that the sample does not include all public pharmaceutical companies due to unavailability of data needed. It may be assumed that by adding data about other 15 companies other results may be obtained.

Secondly, due to the fact that data sample includes only public companies and the number of non-public pharmaceutical companies is significant, further researches may include non-public companies into research sample, if data will be available. Because the number of non-public companies in much bigger than the number of public companies, results may change significantly: some variables may become significant and some, on contrary, won't be significant.

Furthermore, the list of CEO characteristics can be extended. For example, director's business and his or her company ownership may be included in the sample of independent variables.

Although there are some research limitations, the results that have been obtained based on sample of 55 public pharmaceutical companies in EU have clear managerial implications. Discussed limitations do not undermine results of empirical analysis but rather creases possible direction for future research in this field. Companies in pharmaceutical industry that are interested in innovation development can use results obtained.

Conclusion

Nowadays, innovations in pharmaceutical industry are more demanded than ever before. Various healthcare institutions have highly qualified employees who able to develop and implement innovations and manage large innovative projects. Innovations in pharmacy enable to improve the quality of medical care, health care, disease prevention. By creating innovations companies may obtain a competitive advantage that will boost revenues and may also cut costs: that is why topic of innovations in pharmaceutical industry is highly actual. In innovations development the creation of the highly efficient executive management team is crucial. That is why it is highly important to assign to the CEO position person, who will perfectly fit to this role.

This research paper was aimed to identify the relationship between Chief Executive Officer personal characteristics and innovativeness of the public pharmaceutical companies in European Union measured by R&D expenditures and number of new patents obtained. More specifically, the research question that has been stated was about which CEO characteristics are important when company in pharmaceutical industry wants to increase its innovativeness and? If important, than in what extend? In particular, this research covered CEO characteristics such as age, educational level and field, tenure, level of fixed and total remuneration, hiring from inside of outside and director's network.

To achieve stated goal a list of objectives was stated. The logic of this research corresponds to the order of objectives that have been set in the beginning. At first, the literature review on the topic of innovations was done: innovations definition, the role for companies in pharmaceutical industry was analyzed. After, the topic of corporate governance and CEO role was covered: the characteristics of CEO that can be significant were determined and hypotheses were stated. Finally, the empirical models were determined and tested in order to obtain results about the existence of the relationship between personal characteristics of CEO and company innovativeness. After the results have been obtained managerial implications were formulated.

Existing researches claims that personal characteristics of CEO have an impact on different sides of how company operates. Researchers believe that CEO characteristics are important also have an impact, however, sometimes results are controversial, because empirical analysis are conducted on deferent data and sample. For instance, CEO's economic expertise is valuable for company because it leads to effective planning and controlling processes, accurately developed budgets. If such CEO understands the innovations long-term value he or she may also pay a high attention to them. At the same time CEO's economic background usually leads to cost cutting that may be less favorable for innovative projects [Jeanjean, Stolowy 2009]. Such duality

is true for many CEO characteristics that is why this research can be valuable because it provides an insights for companies in pharmaceutical industry: who better suits to the CEO position in pharmacy. To conclude, the following research contributes to the existing pool of literature on the topic of corporate governance because it creates useful managerial implications for companies in pharmaceutical industry.

In this empirical study, the data about 55 pharmaceutical companies in EU was gathered. Data was collected from Tomson Reuters Database, Bloomberg profiles, annual reports for companies and their websites for the 8-year period from 2009 to 2016.

The results of the study show that some characteristics of CEO have a relationship with company innovativeness, measured by R&D expenditures and number of new patents obtained in 2, 3 year period. These characteristics that are considered to be important have to be taken into consideration when CEO assigning. The results obtained by conducting regression analysis support the following conclusions:

1. Young CEOs tend to facilitate to company innovativeness in pharmaceutical industry.
2. CEOs with education in economics tend to facilitate less to innovative development in pharmaceutical company
3. If CEO received master's and doctoral level of education, pharmaceutical company innovates more than if CEO has received only bachelor degree
4. The longer CEO is working in pharmaceutical industry, the more patents company receives
5. The more directors CEO knows the more innovative company is.
6. If CEO was promoted from the position inside the company is more innovative that if CEO is outsider
7. The high total remuneration corresponds to higher company innovativeness.

This research paper has a theoretical contribution to the existing pool of literature about corporate governance by providing more insights about role of CEO characteristics in company innovativeness measured by R&D expenditures and number of new patents obtained. Also, it creates a basis for further research, shaping the direction of possible analysis.

Moreover, research has a managerial implications, based on which the important decision about CEO assignment could be made. To maximize the innovation potential of pharmaceutical company CEOs preferable characteristics has been discussed.

At the same time research has some limitations. Firstly, not all pharmaceutical companies are included in the sample that can have a relationship with obtained results. Also, non-public companies dominate on the market in terms of number of companies and if they would be included into empirical models, the implications would be more valuable for a whole pharmaceutical market. Furthermore, the list of CEO characteristics can be extended.

To conclude, the relationship of personal CEO characteristics and company innovativeness was analyzed. Despite research has some limitations, valuable conclusions as well as theoretical and managerial implications may be derived.

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Appendix 1. Result of Model for R&D

```
Coefficients:
                       Estimate  Std. Error t-value  Pr(>|t|)
XAge                  -1423.2143   4195.0939 -0.3393  0.658926
XMaster              -17715.9222  49491.0916 -0.3580  0.836263
XDoctor               25740.8969  55360.4063  0.4650  0.772852
XMBA                 151556.8372  50523.0621  2.9998 7.999e-05 ***
XMed                  87793.9818  46923.4129  1.8710  0.068528 .
XEconomics           -75733.1470  48908.9964 -1.5485  0.022830 *
XEngineering         -67101.0044  78475.8438 -0.8551  0.148156
XExperience           -1014.9032   3351.8733 -0.3028  0.266943
XTenure               -4684.7263   2427.2135 -1.9301  0.225946
XNetwork.directors     1950.4613   1370.6887 -1.4230  0.065838 .
XNetwork.inductries    5638.1611   5880.9580 -0.9587  0.004894 **
XInsider             111164.4777  39515.1500  2.8132  0.017199 *
XFixed.compensation     281.0858     66.9728  4.1970  0.161227
XTotal.Compensation      25.5855      6.4733  3.9524 8.297e-05 ***
XVariable            -25651.6737  78076.0155 -0.3285  0.377104
XREV.LOG              51256.1395  36110.0774 -1.4194  0.050744 .
XFirm.age             14701.9566   3952.8497  3.7193  0.005511 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    1.4528e+13
Residual Sum of Squares: 8.3533e+12
R-Squared:      0.42501
Adj. R-Squared: 0.31655
F-statistic: 16.8268 on 17 and 387 DF, p-value: < 2.22e-16
```

Appendix 2. Result of Model for New Patents with lag 2

```
Coefficients:
                          Estimate  Std. Error t-value  Pr(>|t|)
X3Age                -4.2063e-01  1.1222e-01 -3.7484 3.072e-10 ***
X3Master              2.1720e+00  1.3848e+00  1.5685 0.0031581 **
X3Doctor              4.3727e-01  1.2504e+00 -0.3497 0.1198090
X3MBA                 5.7542e-01  1.3510e+00 -0.4259 0.0219857 *
X3Med                 1.8523e+00  1.4485e+00  1.2788 0.0354326 *
X3Economics          -3.4970e-01  1.3742e+00  0.2545 0.0009382 ***
X3Engineering         2.3619e-01  1.8243e+00  0.1295 0.1057703
X3Experience          2.7616e-01  8.5195e-02  3.2415 3.625e-11 ***
X3Tenure             -1.4371e-01  8.3785e-02 -1.7153 0.2623981
X3Network.directors   6.7250e-02  3.6802e-02  1.8273 0.0049149 **
X3Network.inductries  1.1750e-01  1.9562e-01 -0.6007 0.5259903
X3Insider             2.7843e+00  1.1194e+00 -2.4872 0.0002319 ***
X3Fixed.compensation -6.6826e-03  2.3306e-03 -2.8674 0.6143493
X3Total.Compensation  6.2363e-05  2.8015e-04 -0.2226 0.9983594
X3Variable           -3.7342e+00  3.0332e+00 -1.2311 0.7987580
X3REV.LOG             5.1653e+00  1.0641e+00  4.8544 < 2.2e-16 ***
X3Firm.age            3.1123e-02  1.0792e-02  2.8839 0.0002183 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    1.0779e+14
Residual Sum of Squares: 5.7353e+13
R-Squared:      0.46791
Adj. R-Squared: 0.36545
F-statistic: 5.16614 on 17 and 297 DF, p-value: 6.1832e-10
```

Appendix 3. Result of Model for New Patents with lag 3

```
Coefficients:
                          Estimate  Std. Error t-value  Pr(>|t|)
X4Age                 -0.23440769  0.13165098 -1.7805 4.754e-07 ***
X4Master               2.37568709  1.55207435  1.5307 1.735e-06 ***
X4Doctor               1.19705579  1.41818077 -0.8441  0.034703 *
X4MBA                  0.08789844  1.56918119  0.0560  0.006522 **
X4Med                  1.09912398  1.70982233  0.6428  0.885962
X4Economics           -0.54599178  1.51633898  0.3601 1.511e-10 ***
X4Engineering         -0.57408611  1.91632133 -0.2996  0.555968
X4Experience           0.18441646  0.09494838  1.9423 2.929e-05 ***
X4Tenure              -0.20027424  0.09715943 -2.0613  0.233936
X4Network.directors    0.12808152  0.04115078  3.1125 < 2.2e-16 ***
X4Network.inductries   0.44283514  0.23078238  1.9188  0.305312
X4Insider              0.50045662  1.29986993 -0.3850  0.002078 **
X4Fixed.compensation  -0.01083344  0.00265787 -4.0760  0.014813 *
X4Total.Compensation   0.00027172  0.00034522 -0.7871  0.011744 *
X4Variable            -5.52993950  3.45356112 -1.6012  0.596861
X4REV.LOG              5.04057064  1.25093310  4.0294 6.395e-14 ***
X4Firm.age             0.04614776  0.01157661  3.9863  0.018615 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    9.5225e+13
Residual Sum of Squares: 3.1248e+13
R-Squared:      0.67185
Adj. R-Squared: 0.60464
F-statistic: 8.64283 on 17 and 250 DF, p-value: < 2.22e-16
```